TITLE OF THE INVENTION

PRESSING IRON HAVING AN ELECTRO-OSMOTIC PUMP

BACKGROUND OF THE INVENTION

[0001] The present invention relates to steam pressing irons, and similar appliances such as steam wrinkle removers. In such appliances, water is conveyed slowly from a reservoir to a steam chamber in which water is converted into steam. More particularly, the invention concerns means for conveying the water into the steam chamber.

[0002] The most well known devices for this purpose are drip devices functioning by gravity, but they have the drawback that they cease to function when the pressure of steam in the steam chamber becomes higher than that of the column of water available above the drip device.

[0003] One solution to this problem consists in adapting an electromagnetic piston or membrane pump actuated by an electromagnet or an electric motor. Such devices are described, for example, in French patents numbers FR2368862 and FR2690932. Also known are rotary pumps such as centrifugal pumps as described in French patent number FR2688013 as well as peristaltic pumps, an example of which is disclosed in French patent number FR2691210, less commonly used.

[0004] These types of pumps have proven satisfactory with regard to flow rate and pressure. However, they also generate noise and vibrations, their flow rate is not easily variable, which leads them to operate in bursts, and they are relatively costly.

BRIEF SUMMARY OF THE INVENTION

[0005] The present invention provides a household electric appliance containing a water reservoir that may be filled with tap water and that is equipped with a pump that is silent, economical and durable to transfer water from the reservoir toward the steam chamber, with a continuous flow rate that is easily adjustable with precision and is interruptible, as well as having a sufficient pressure to overcome the counter pressure generated in the steam chamber during ironing.

[0006] Primarily, the invention is embodied in an ironing appliance having a water reservoir and a pump for transferring water from the reservoir toward the steam chamber, wherein the pump is an electro-osmotic pump.

[0007] An electro-osmotic pump, as contemplated by the present invention, is a device having a first compartment that is normally connected to the water reservoir or that forms a part of this reservoir, and a second compartment connected to the steam chamber in which water transferred by the pump is

converted into steam, the two compartments being separated by a porous solid body. Each compartment is furnished with an electrode in proximity to the porous body, the electrodes allowing water to flow therepast.

[0008] Thus, when a voltage is applied between the electrodes, a flow of water is created from the first compartment toward the second compartment and supplies the steam chamber. The principle of an electro-osmotic pump is described for example in US patent 3,143,691. This document cites the pressures obtained with water, which reach the equivalent of a height of water of 11 mm per volt applied between the electrodes. However, the device described only transfers water from one chamber to another without flowing in a circuit, or serves to detect a pressure or flow rate.

[0009] Uses are known in fields that are radically different from that of the present invention. For example, French patent FR1446109 describes numerous devices using a pump of this nature, but with non-aqueous liquids. Several patents also describe medical uses for distributing medications in very small quantities, uses in chromatography to cause an electrolyte to circulate in a column, and uses in fluidics with low flow rates as in US patent 6,012,902.

[0010] All of these uses concern movements of electrolytes or diverse solutions having characteristics far removed from running water, generally in fields that are very sophisticated and that involve low flow rates.

[0011] French patent FR2467178 describes a water purifier using electro-osmotic pumps, but the pumps used only operate if the water is purified, by resin devices that demineralize the water.

[0012] None of the above-cited documents envisions or suggests the utilization of such a pump in a household electric appliance, or even less in a pressing iron. However, an iron provided with an electro-osmotic pump performs particularly well and is particularly quiet.

[0013] The pump is placed between the reservoir and the steam chamber. Its water inlet communicates with the reservoir or is located within the reservoir, while its outlet is connected to the steam chamber.

[0014] According to one embodiment, the pump is constituted by an enclosure made of electrically non-conductive plastic, containing a porous body composed of grains of fritted glass, in the form of a disc occupying the entire cross-section of the enclosure. The fluid inlet and outlet are arranged at respective opposite sides of the porous disc. Two electrodes

are placed to one side and the other of the disc, in contact with the fritted glass and in the path of the fluid. The pump is actuated by application of a direct voltage between the electrodes, of the order of 10-200 volts. Water is displaced, in this case of a siliceous covering of the disc, from the anode toward the cathode, the flow/pressure characteristic being linear and being directly dependant on the applied voltage.

[0015] Preferably, the cross-section of the porous body corresponding to the water passage has dimensions greater than the thickness of the porous body.

[0016] Specifically, the diameter of the disc is greater than its thickness. This thus avoids having a localized bubble in the porous body interrupt the passage of the electric current and the operation of the pump. In effect, a possible gas bubble, generated by the electrodes and trapped in the porous body, cannot have a diameter greater than the thickness of the porous body and thus cannot obstruct the entire passage cross-section for the water and the electric current.

[0017] In a preferred embodiment, the porous body is constituted by a bed of grains of very fine alluvial sand having a grain size of 0.2mm or less.

[0018] Thus, fritted glass is replaced by the sand. This provides an economical form of construction of the medium in which the electro-osmosis is produced. Preferably, the porous body is of a siliceous nature, such as a quartz sand.

[0019] The bed of grains is maintained in an enclosure made of plastic by the electrodes, which are preferably made of stainless steel and provided with holes, the electrodes being placed on two flat faces of the bed.

[0020] Preferably, the electrodes are made of sheets of stainless steel that are perforated and expanded.

[0021] The electrodes do not significantly interfere with the passage of water in the pump.

[0022] Preferably, the electrodes are separated from the bed of grains, which they retain, by porous membranes.

[0023] The membranes aid retention of the sand so that the perforations in the electrodes do not have to be particularly small.

[0024] The electric supply of the pump, for reasons of safety, includes a transformer or a switch mode power supply including a galvanic isolation.

[0025] The invention also permits a linear variation of the flow rate by modification of the direct voltage applied between the electrodes.

BRIEF DESCRIPTION OF THE DRAWING

[0026] Figure 1 is an elevational, cross-sectional view of an iron according to the invention.

[0027] Figure 2 is a cross-sectional detail view, to a larger scale than figure 1, of a preferred embodiment of a pump according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0028] According to a preferred embodiment, shown in figure 1, a steam iron 1 includes an integrated water reservoir 11, and a soleplate 12 heated by a heating body 13 furnished with a heating element 131. A steam chamber 132, closed by a plate 133, is arranged in heating body 13. Steam produced in chamber 132 escapes through steam holes 121 in the ironing face of soleplate 12.

[0029] An electro-osmotic pump 2 is installed at the rear of water reservoir 11. Preferably, the pump is present in the form of a cassette 21 introduced into the bottom of reservoir 11 from the rear of the iron, before closing the heel of the iron by the heel piece 14 during fabrication of the iron. A

sealing joint 211 assures a liquid tight seal between the cassette and the wall of reservoir 11. As a result of this arrangement, the pump is easily removable and replaceable when it eventually becomes ineffective. At the rear of the iron, the pump remains immersed in water even when the iron is placed on its heel piece 14.

[0030] As shown in figure 2, pump 2 has a water outlet 212 that is accessible to the exterior to the reservoir. Water outlet 212 is connected to a point 134 at which water is injected into steam chamber 132 through a conduit 15. Conduit 15 has at a high point along its path a shunt 151 toward a high point of reservoir 11. Shunt 151 is provided with a calibrated orifice 152, opening into the high point of reservoir 11, with a diameter of several tenths of a millimeter, which is small relative to the diameter of conduit 15.

[0031] With this arrangement, introduction of air through orifice 152 interrupts any siphoning from reservoir 11 toward steam chamber 132 when the iron ceases being used but remains with the soleplate flat on the ironing surface. In effect, this siphon action, although very slow due to the substantial loss of head in pump 2 when it is halted, would be possible since reservoir 11 is placed higher than the point 134 at

which water is injected into steam chamber 132. When the pump is in operation, the flow of water toward reservoir 11 through orifice 152 is negligible.

[0032] Further referring to figure 2, pump 2 includes an envelop 21 in the form of a cassette, divided vertically into two compartments 213, 214. These two compartments are separated by a porous body 220 that may be in the form of a disc. Preferably, the disc has a circular, cylindrical form, with an axis that is vertical in the plane of figure 2. According to a preferred embodiment of the invention, body 220 has a diameter of the order of 40mm, and a thickness of 10mm. However, disc 220 can have any other outline that is compatible with the internal configuration of the reservoir. Disc 220 is enclosed laterally by a ring 221, preferably made of electrically insulating plastic material, this ring facilitating fabrication of the body. Ring 221 is clamped in cassette 21 by internal parts 215, which helps to assure the formation of a fluid tight seal around ring 21 between compartments 213 and 214.

[0033] Porous body 220 is preferably constituted by a bed of alluvial siliceous sand having a grain size of less than 0.2mm. Each exposed face of disc 220 is covered with a membrane 22 and an electrode 223. Each membrane 22 is

permeable to water, and may be made, for example, of filter paper, and each membrane 22 is in contact with body 220. Each electrode 223 overlies its associated membrane 222 and may be made of an expanded stainless steel sheet that serves to retain the shape of the porous body. Each electrode is connected by a soldered connection 224 to a pin, such as 216, that passes through the wall of cassette 21 that is outside reservoir 11. According to another form of construction, the electrodes can be made of an expanded titanium sheet, preferably having a platinum coating.

[0034] A connector (not shown) connects pins 216 to a direct current source, with the lower electrode being the anode and the upper electrode being the cathode. The direct current source can be disposed in the handle of the iron and can be a transformer or a switch power supply including a galvanic isolation with respect to the power mains and the body of the iron. Voltage applied between the electrodes during operation of pump 2 can be regulated by the user, from 10 to 200 volts.

[0035] Lower compartment 213 of pump 2 is open at the bottom and laterally to communicate with the interior of reservoir 11 so that water contained in reservoir 11 will

enter compartment 213 and moisten body 20 by capillarity. Upper compartment 214 is coupled to pump outlet 212.

[0036] When the iron is ready to be used and the user wishes to produce steam, he adjusts the output voltage of the constant current source by acting on a suitable button or switch that can be graduated in terms of steam flow rate. The voltage applied between electrodes 223 provokes an ion current along the walls of the capillary network constituted by the grains of sand, thus entraining molecules of water in the direction of the cathode in the case of a porous siliceous body. Water passes from reservoir 11 into compartment 213 then through body 220, into compartment 214 and then out through outlet 212, which may be in the form of a nipple, and finally through conduit 15, in order to reach point 134 where water is injected into the steam chamber.

[0037] The thickness of the porous body being constant, the water flow rate is directly proportional to the voltage applied between the electrodes. If there is a slight liberation of gas at the electrodes due to electrolysis of the water, the gas forms into bubbles. The diameter of the bubbles cannot exceed the thickness of the disc constituting body 220, which thickness is less than the diameter of the body. Therefore, the bubbles cannot completely interrupt the

ion current between the electrodes and can thus not cause an undesired blockage of pump operation. On the contrary, these bubbles will be entrained and evacuated along with the water current.

[0038] The device as described produces, when supplied with a direct voltage of 200 volts, a water flow rate of around 20 g/min under a pressure of several tens of millibars, much greater than the column of water available in the iron above injection point 134, fully sufficient to overcome the counter pressure due to the steam produced in chamber 132 and to assure easy ironing. Since there is no mechanical moving part, the pump operation is completely silent.

[0039] When the user finishes ironing, and if he allows the iron to cool while left to rest on soleplate 12, conduit 15 empties slowly through injection point 134. Air inlet 152 prevents water from being inadvertently siphoned out of reservoir 11, through pump 2.

[0040] In a related form of construction, conduit 15 has, upstream of shunt 151, a 3-way valve that permits, under control of the user, the supply of water to a sprayer 16 situated at the front of the iron in order to moisten items to be ironed.

[0041] According to another form of construction, porous body 222 is constituted by a bed of mixed grains including grains of ion exchange resin having a small grain size. The polarity of the direct current source is selected as a function of the nature of the majority of the grains. The porous body has the double function of a capillary substrate for the electro-osmosis, and a demineralizing system. Water outlet 212 and the associated end of conduit 15 are modified to facilitate a rapid connection suitable for a relatively frequent replacement of the cassette necessitated by the limited lifetime of such resins.

[0042] By these means, there is obtained an ironing appliance having a pump that is silent, economical, reliable and durable for transferring water from the reservoir toward the steam chamber with an easily regulatible constant flow rate and with a pressure sufficient to overcome the counter pressure generated in the steam chamber as a result of the generation of steam during ironing.

[0043] This application relates to subject matter disclosed in French Application number FR 03 01031, filed on January 30, 2003, the disclosure of which is incorporated herein by reference.

[0044] While the description above refers to particular embodiments of the present invention, it will be understood that many modifications may be made without departing from the spirit thereof. The accompanying claims are intended to cover such modifications as would fall within the true scope and spirit of the present invention.

[0045] The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.